An overview of AIRS trace gases

Aura Science Meeting, October 4, 2007

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With thanks to Xun Jiang, Eric Maddy, Sharon Okonek, Laura Pan,
Ed Olsen, Jennifer Wei and Xiaozhen Xiong

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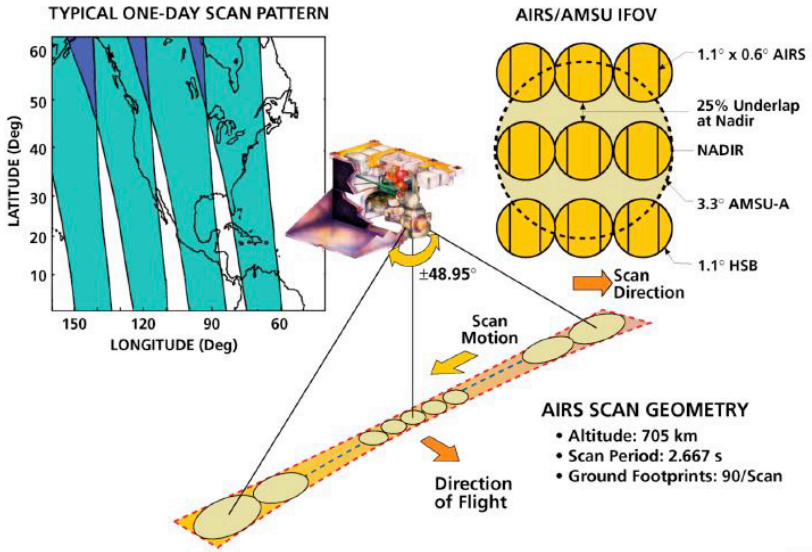
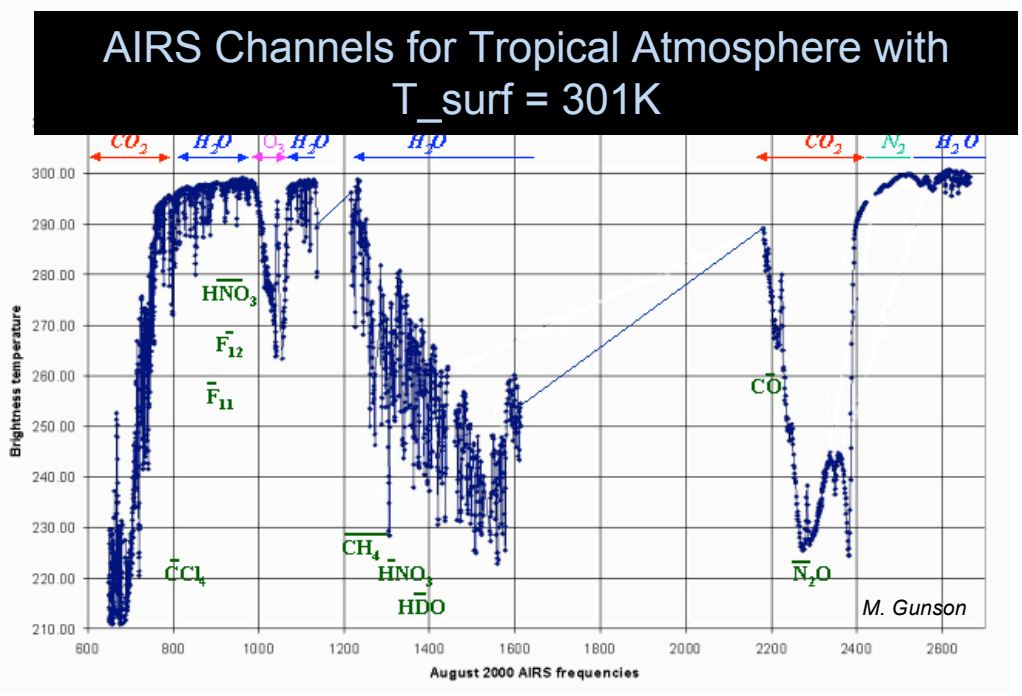
Observation geometry and spectra



~ 324,000 obs./24hr day
~ 270,000 cloud-cleared

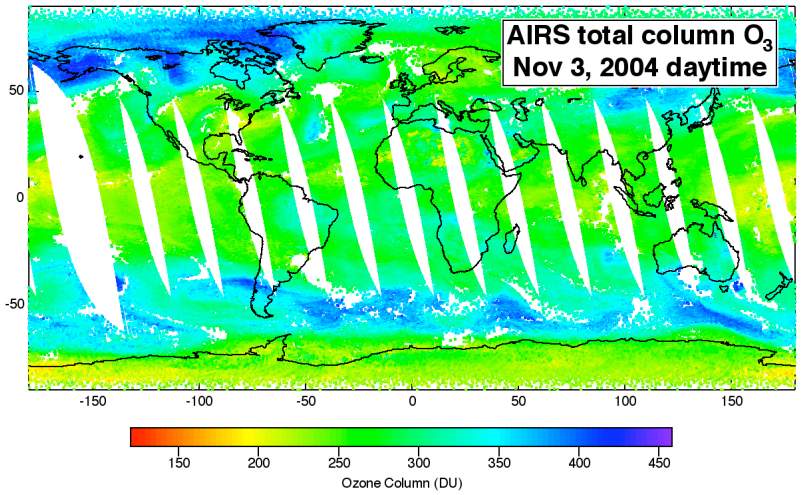
~45 km horizontal resolution

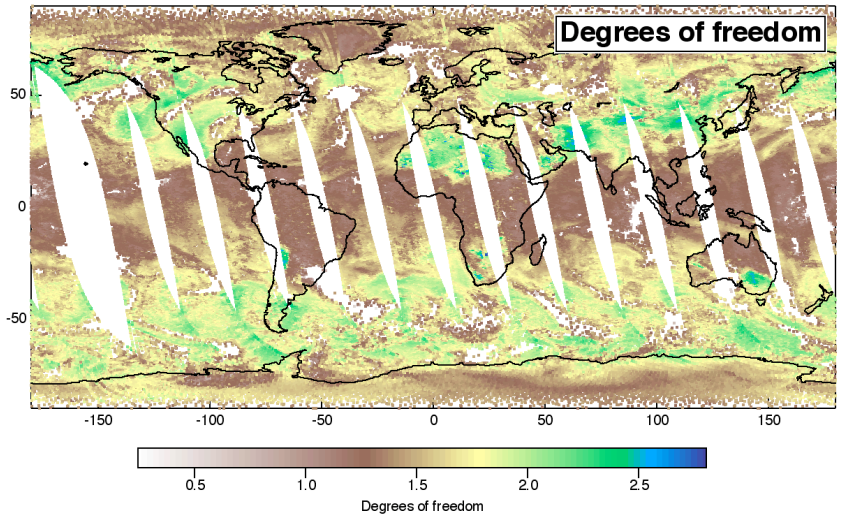
Designed primarily for water vapor and temperature measurement but contains info on several trace gases



Improvements in ozone retrieval

- Version 5 uses climatology and not ECMWF-trained regression in first guess
- Uses an increased number of channels in 10 μm band
- Improved information content analysis for each retrieval



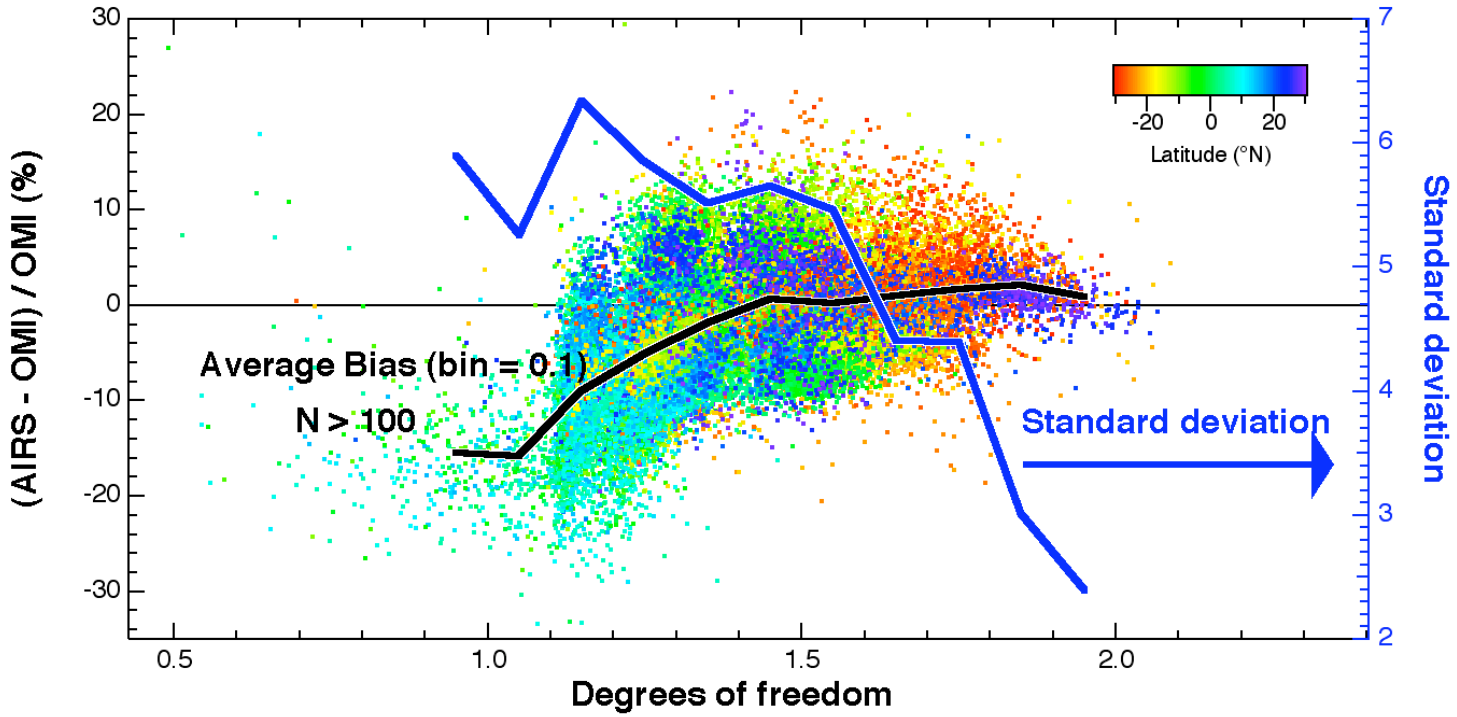


See Divakarla et al., Evaluation of Atmospheric Infrared Sounder (AIRS) Ozone Profiles and Total Ozone Retrievals, in preparation for *J. Geophys. Res*.

AIRS information content analysis described by Maddy et al., submitted to *IEEE Trans. Geosci. Remote Sens.*

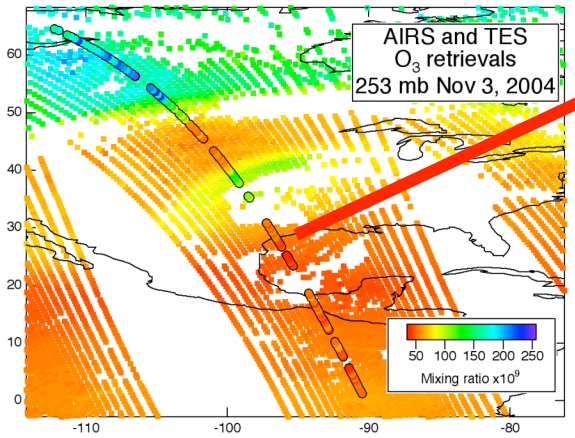
Tropical/subtropical AIRS/OMI comparison

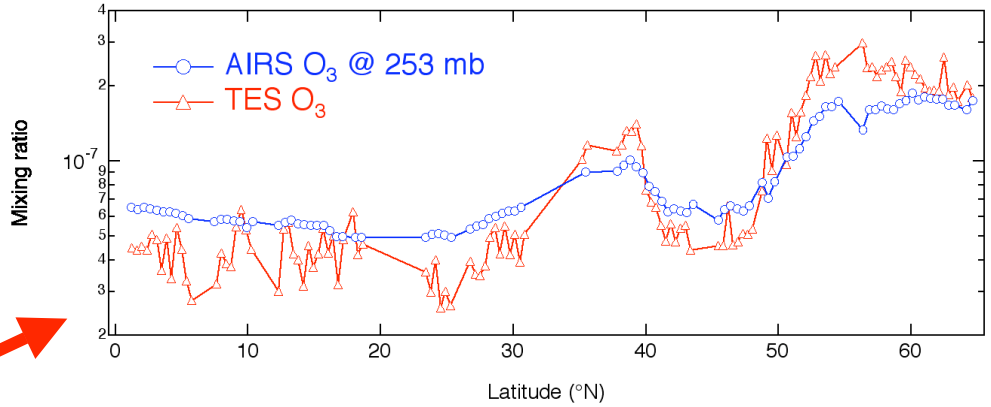
AIRS-OMI ocean only relative difference
30°S - 30°N, Nov 3/2004

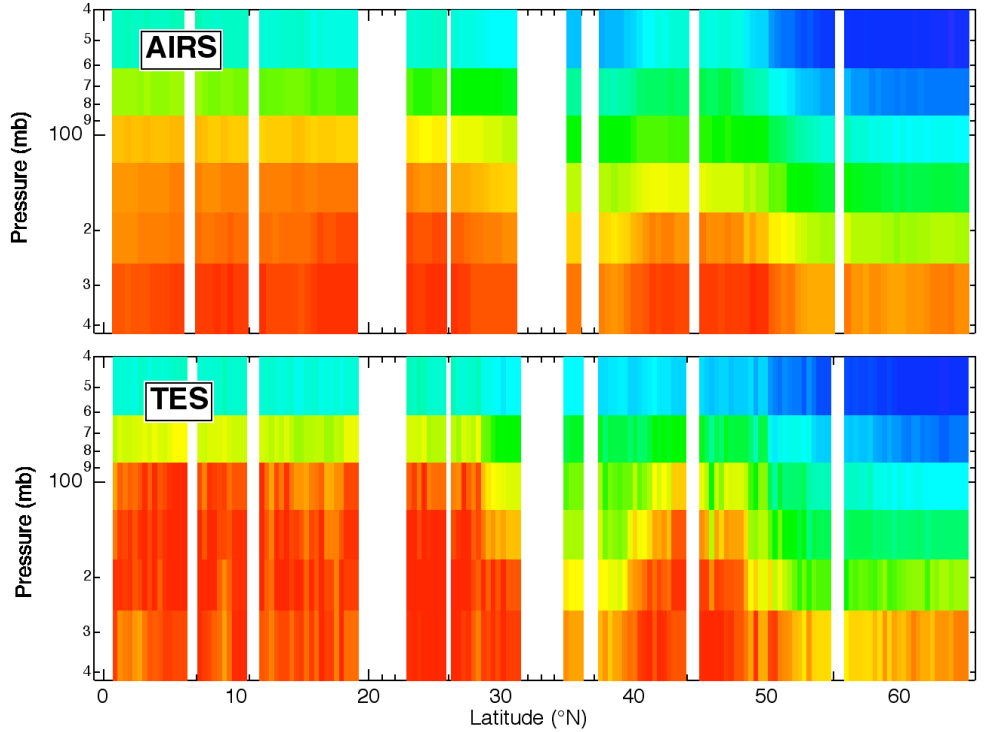


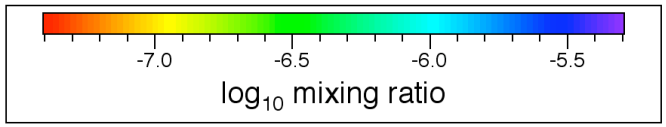
Ozone column agreement improved with increased DOF

AIRS/TES ozone comparison in the UTLS









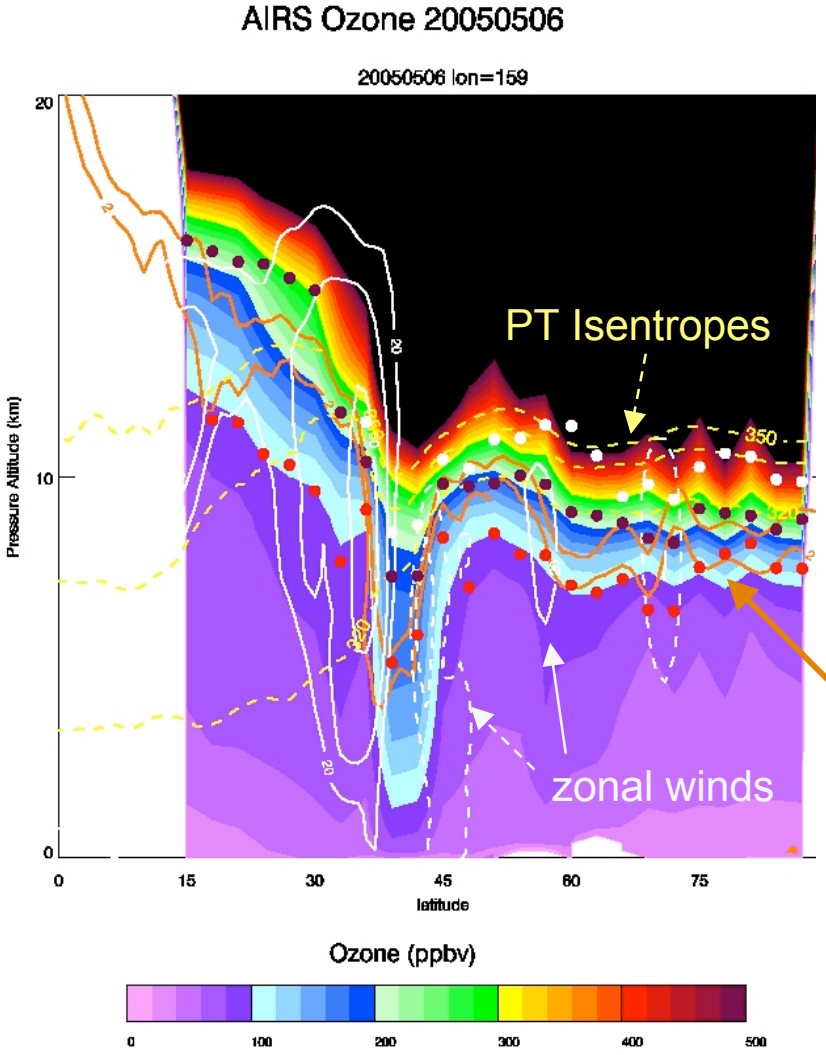
(TES retrievals shown only when there was a matchup with AIRS)

AIRS ~45 km horz. resolution
TES ~8x5 km horz. resolution

Sensitivity may differ but there's similarity on main features.

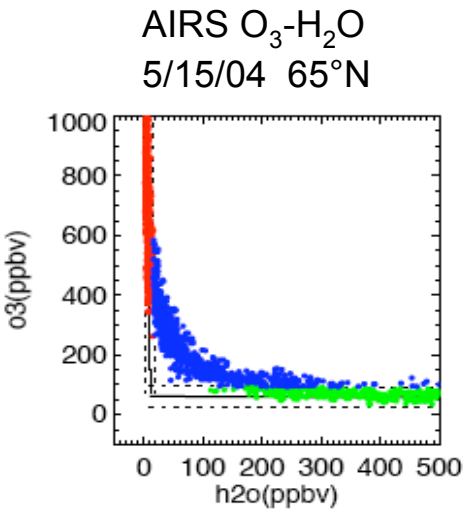
Mixing in extratropical tropopause region

Jennifer Wei (NOAA) and Laura Pan (NCAR)



In general, AIRS O_3 shows good agreement with dynamical variability.

- o upper bound of mixing
- thermal tropopause
- lower bound of mixing



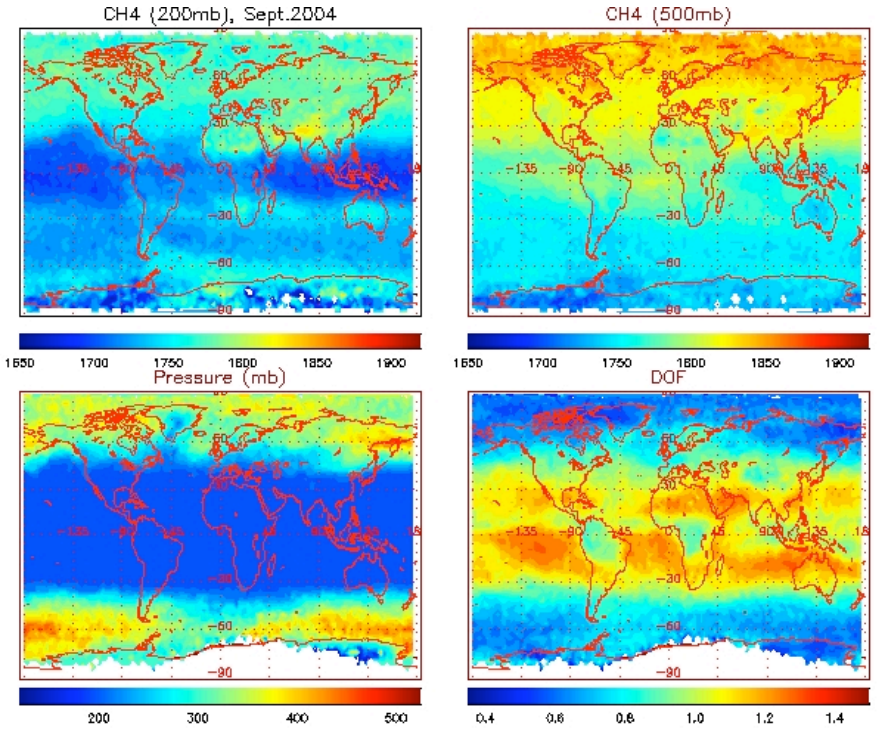
Correlation of O_3 and H_2O and distance from thermal tropopause used in mixing studies in extra-tropical UTLS.

New methane product

Work by Chris Barnet and colleagues

AIRS monthly average, September 2004

200 mb CH_4



500 mb CH_4

Maximum sensitivity level

Degrees of freedom

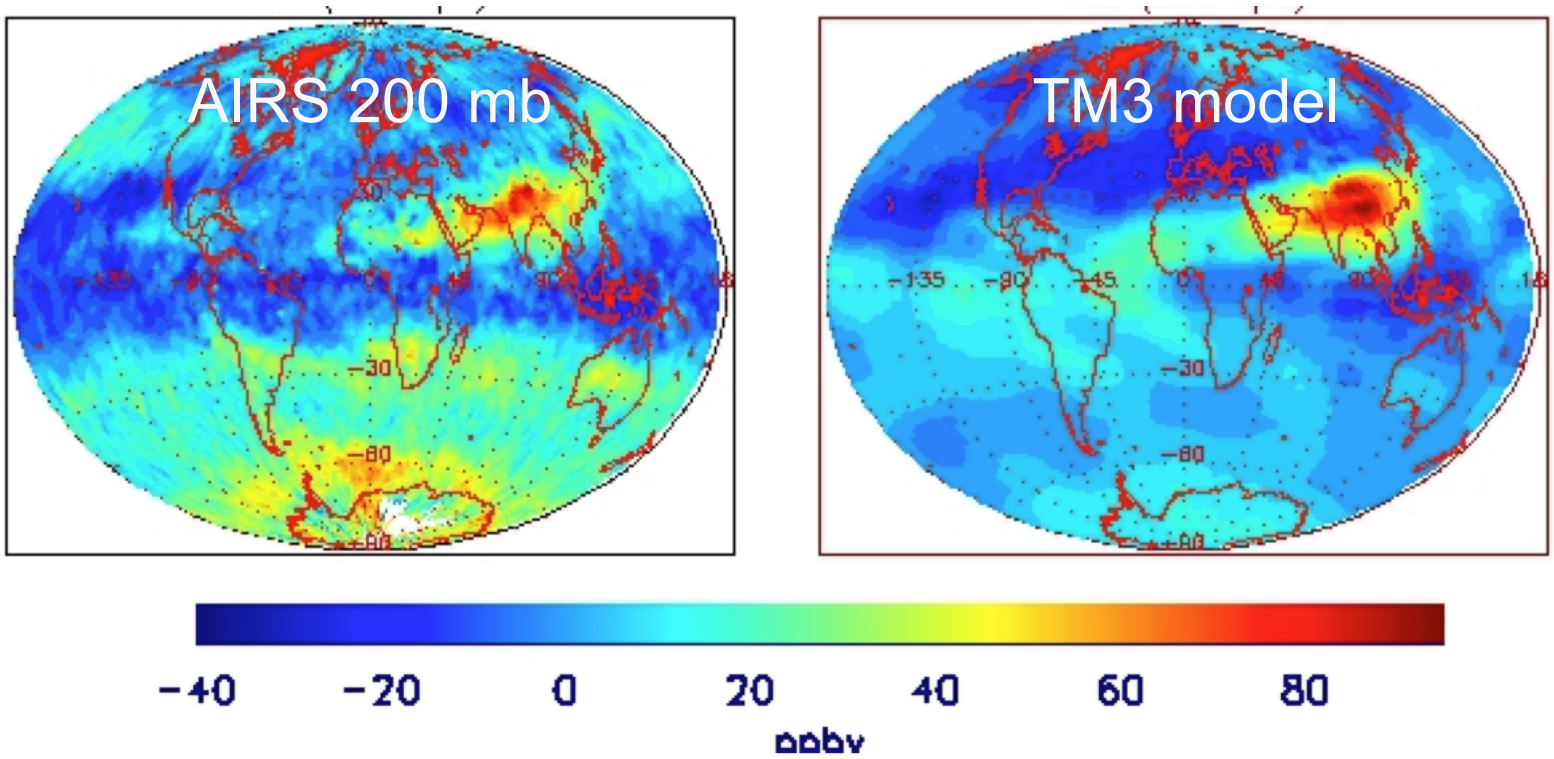
Ref: Xiong, X. et al. (2007), Characterization and Validation of Methane Products from the Atmospheric Infrared Sounder (AIRS), *J. Geophys. Res.* (under revision)

Seasonal methane increase over Tibetan Plateau

Xiaozhen Xiong and colleagues

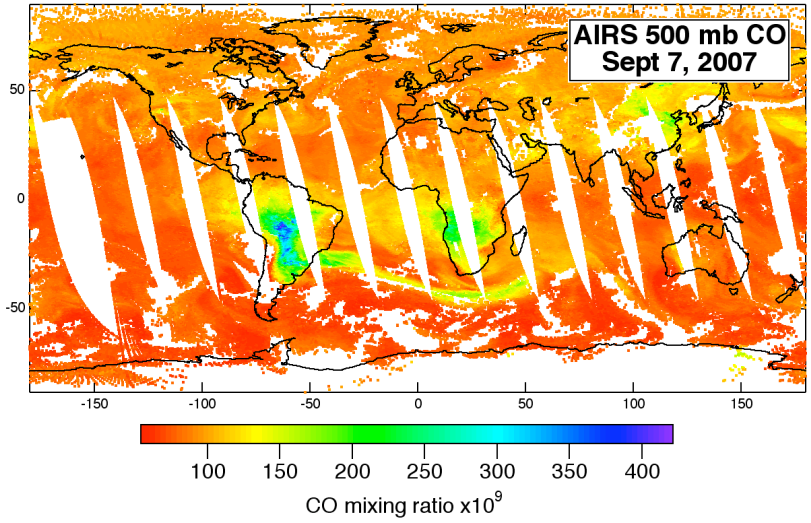
Convection of boundary layer methane to plateau during monsoon

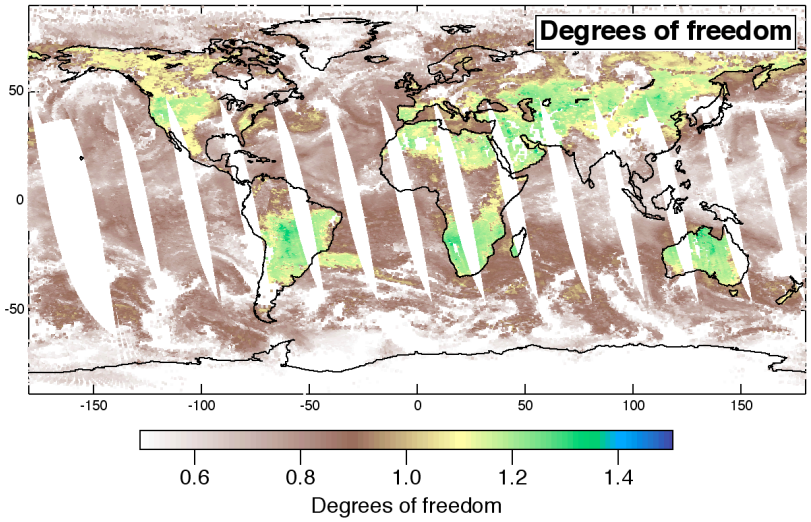
September minus May 2004 methane difference



Ref: Xiong, X., C. D. Barnet, S. Houweling, J. Wei, E. Maddy, X. Liu, M. Divakarla, L. Zhou, and M. Goldberg (2007), Methane Plume over the Tibetan Plateau during the Asian Summer Monsoon Observed from AIRS and its Comparison with Model, submitted to *Geophys. Res. Lett*.

Improvements in carbon monoxide

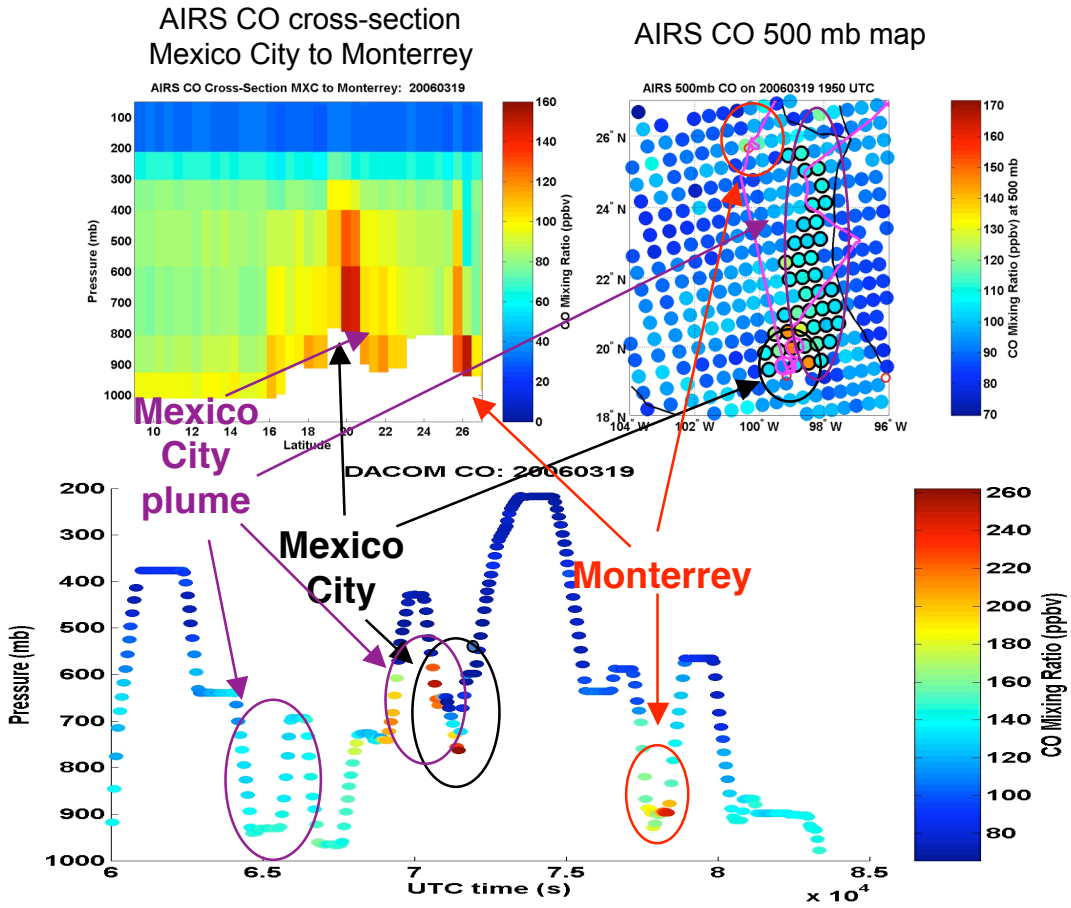




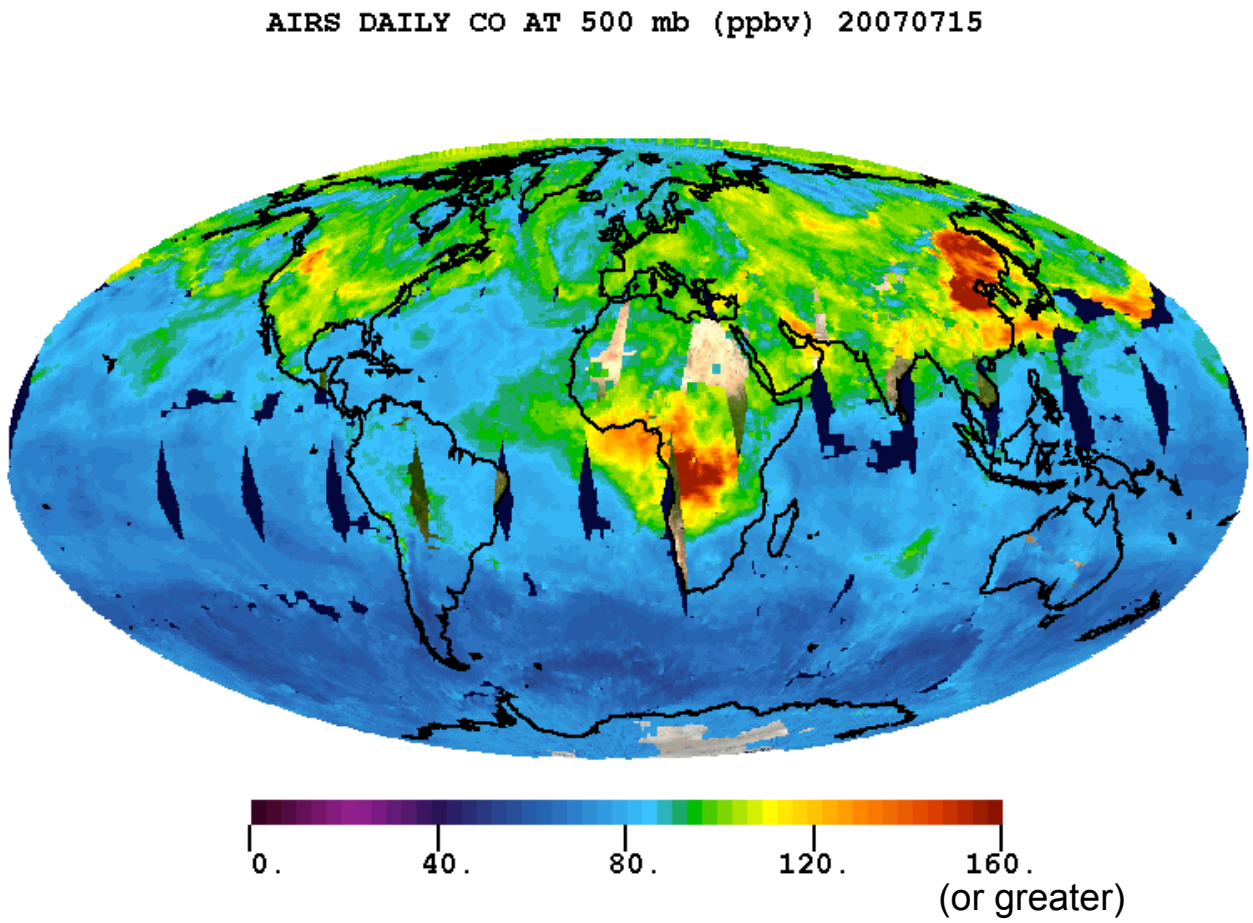
- Increased number of “perturbation functions” in retrieval
- A *priori* same as that for MOPPIT in Version 5
- Best sensitivity around 500 mb, but good sensitivity at higher pressures under certain conditions
- About 0.5 to 1.5 degrees of freedom for column

NSF/NASA MILAGRO campaign

Work by Wallace McMillan and colleagues



Biomass burning CO



Credit to Ed Olsen for the movie

Middle tropospheric CO_2

Work by Mous Chahine and colleagues

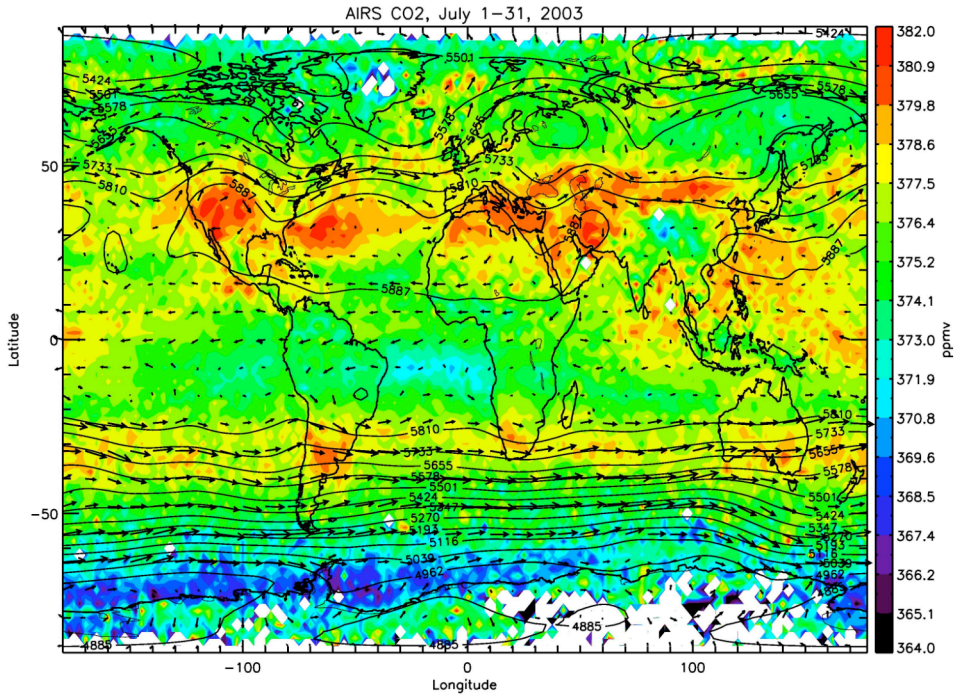
Research product by technique of Vanishing Partial Derivatives.

First *global* mapping of CO_2 by radiance spectra. The results are consistent with the aircraft data and large-scale circulations.

Best sensitivity at 300 - 500mb.

Other methods published/under study: Barnet et al., Engelin et al., Strow et al., Chédin and Crevoisier

CO_2 July, 2003



Contours – 500 hPa geopotential heights

Arrows – 500 hPa wind vectors

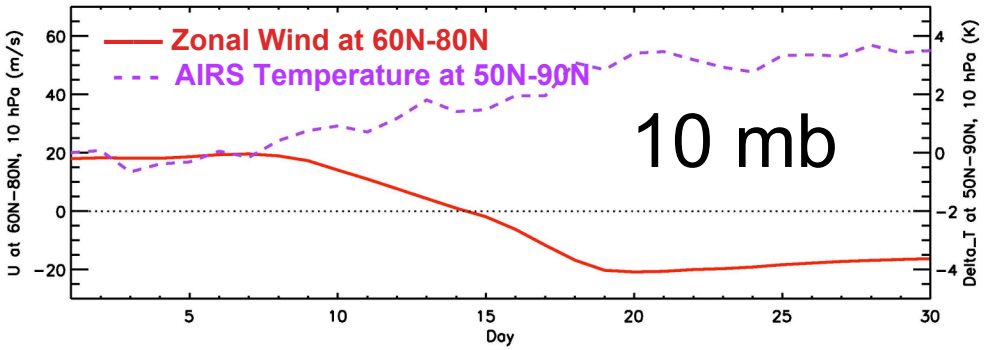
Ref: Chahine, Jiang, Li, Olsen, Chen, Yung and Randerson, "AIRS CO2 in the Upper Troposphere," presentation at 4th IWGGMS, Paris, 25 June 2007. See also Chahine M., C. Barnet, E. T. Olsen, L. Chen, and E. Maddy (2005), On the determination of atmospheric minor gases by the method of vanishing partial derivatives with application to CO 2, *Geophys. Res. Lett., 32*, L22803, doi:10.1029/2005GL024165.

Influence of Sudden Stratospheric Warming on UTLS CO_2 and O_3

Xun Jiang, Moustafa T Chahine, Qinbin Li, Edward T Olsen, Luke L Chen, Yuk L Yung

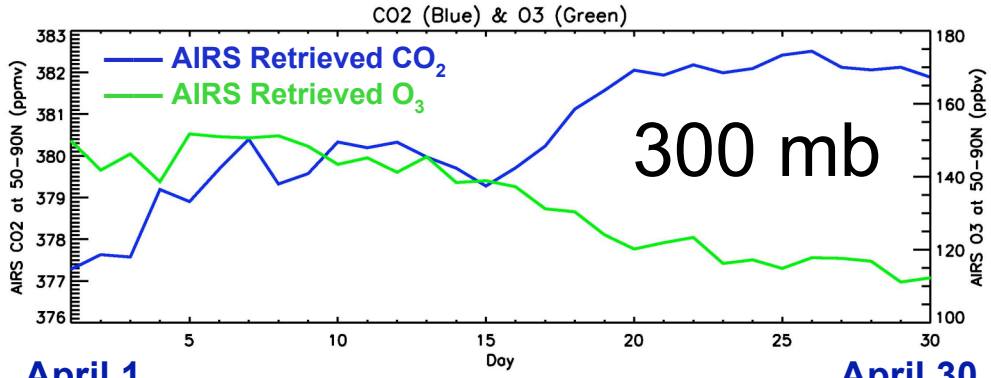
Final breakup of the vortex

U (m/s)
60°-80°N
(from NCEP)



ΔT (K)
50°-90°N

CO_2 (ppmv)
50°-90°N



O_3 (ppbv)
50°-90°N

Both CO_2 and O_3 retrieved by Vanishing Partial Derivatives method.

April 1 2003 — **April 30 2003**

UTLS CO_2 increases while O_3 decreases

Summary

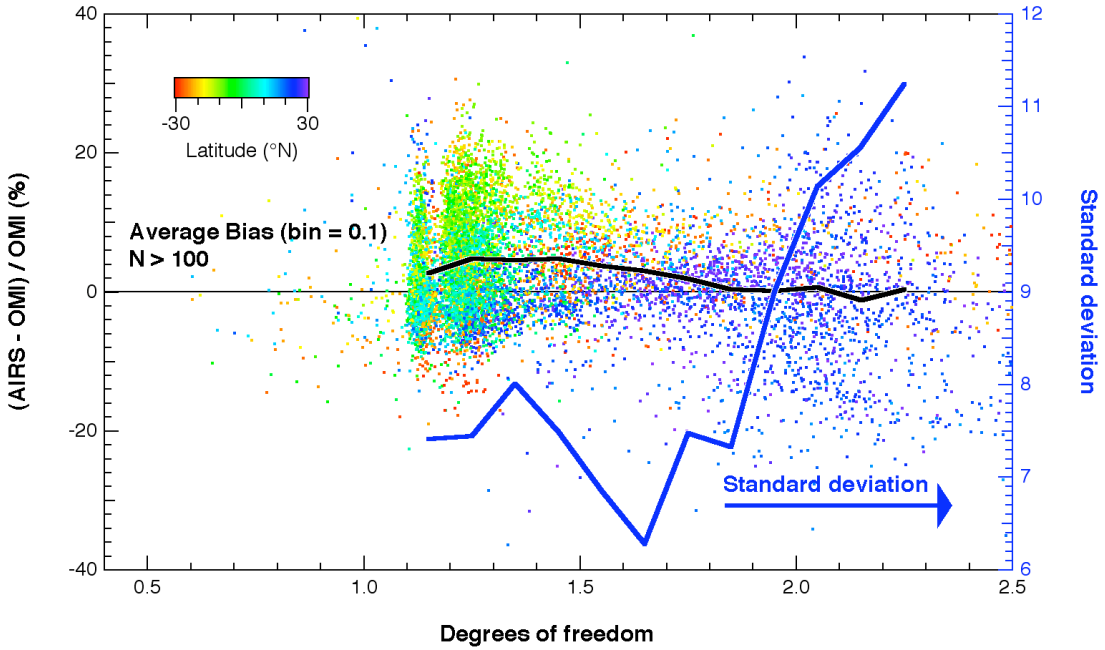
- Version 5 brings substantial improvements to AIRS ozone and carbon monoxide and a new product in CH_4.
- New information content metadata can help in using (or comparing) AIRS O_3, CO and CH_4 in models.
- Re-processing of observations since 9/2002 ongoing and available from Goddard DISC.

- More about AIRS CO_2 at Fall AGU session on “Space Observations of Atmospheric Carbon Dioxide”.

Backup slides

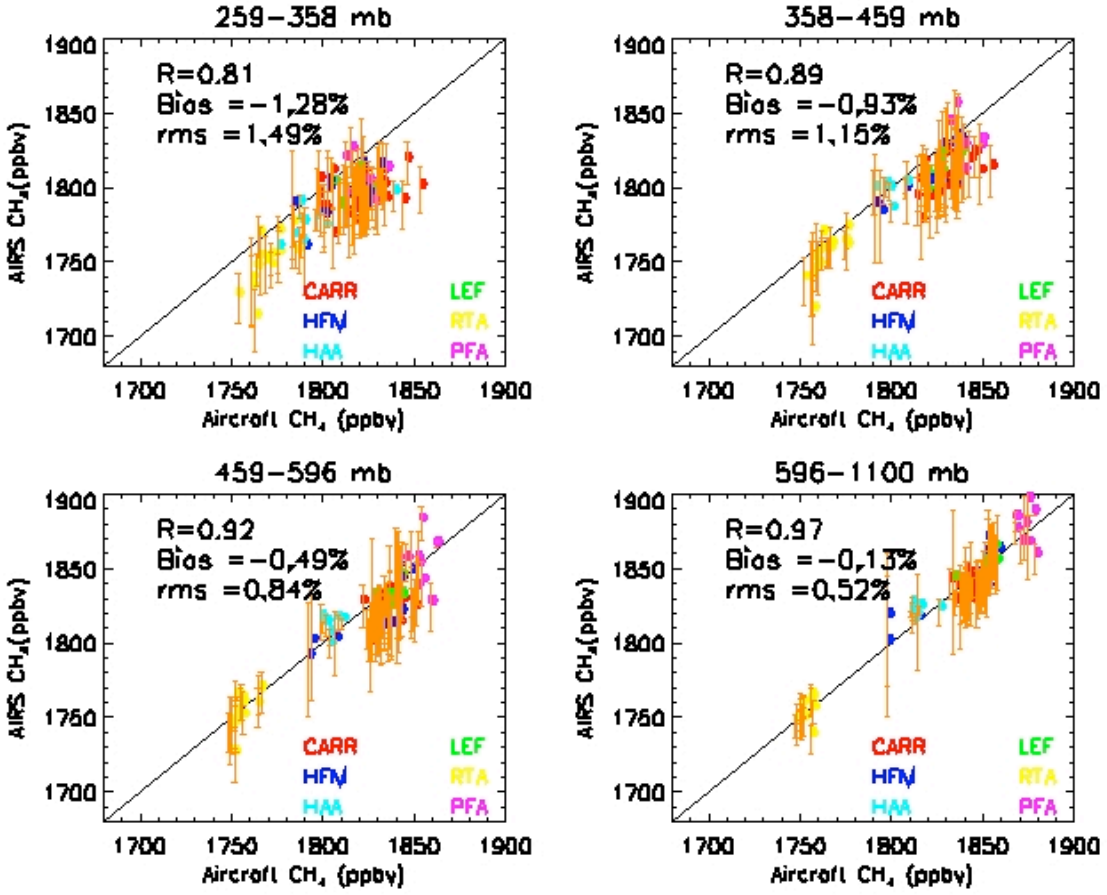
Tropical/subtropical land-only AIRS/OMI comparison

AIRS-OMI land only relative difference
30°S - 30°N, Nov 3/2004



Increased std dev from higher surface temperature but uncertain emissivity? Mostly desert regions?

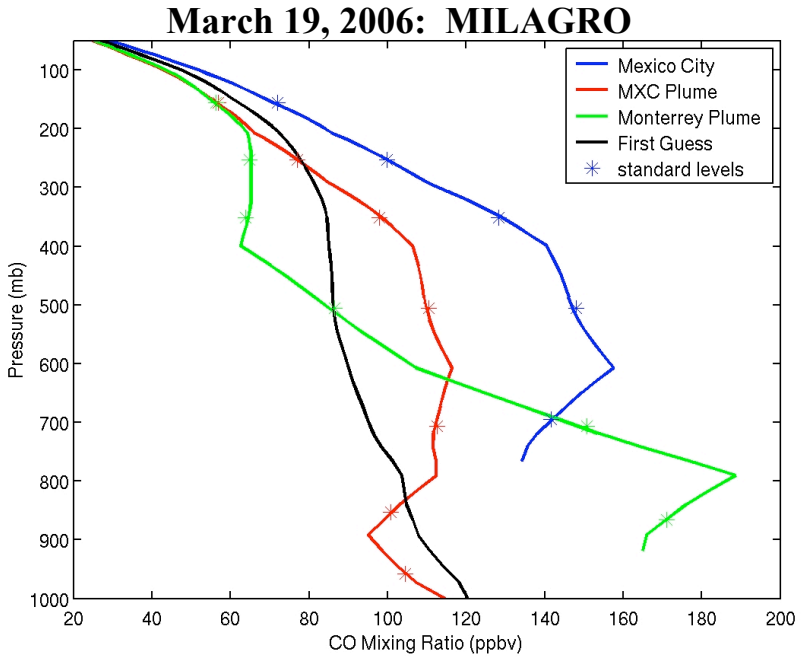
AIRS/aircraft CH_4 comparison



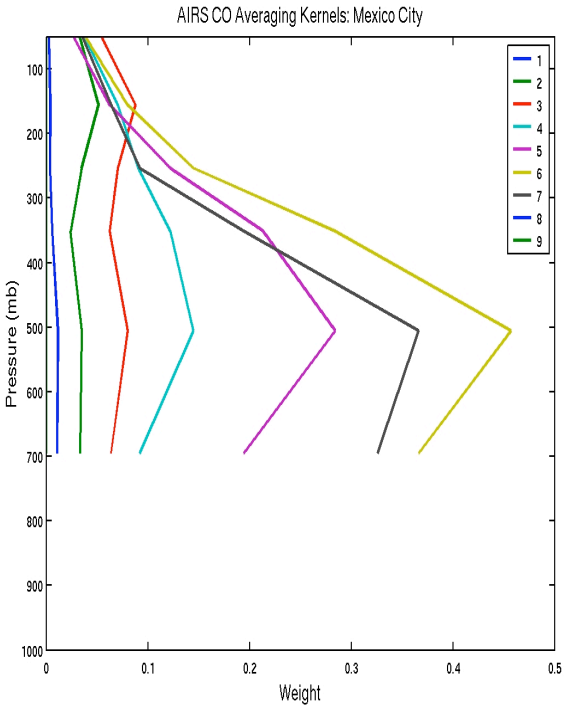
RTA	Rarotonga, Cook Islands	21.25°S	159.83°W	CAR	Briggsdale, CO	40.37°N	104.30°W
HAA	Molokai Island, HI	21.23°N	158.95°W	HFM	Harvard Forest, MA	42.54°N	72.17°W
PFA	Poker Flat, AK	65.07°N	147.29°W	LEF	Park Falls, WI	45.93°N	90.27°W

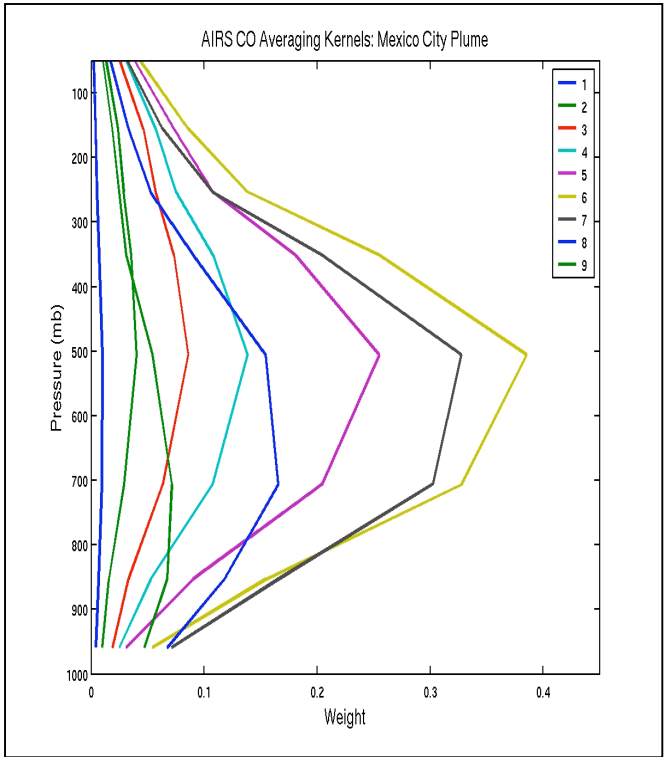
AIRS Milagro Averaging Kernels

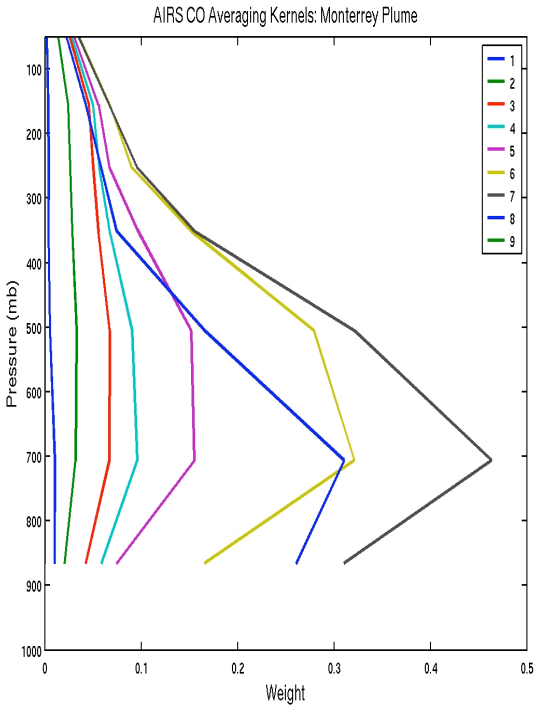
v5 AIRS CO retrievals have greater specificity of vertical sensitivity and provide averaging kernels to document this and enable comparison to models, in situ, and satellites.



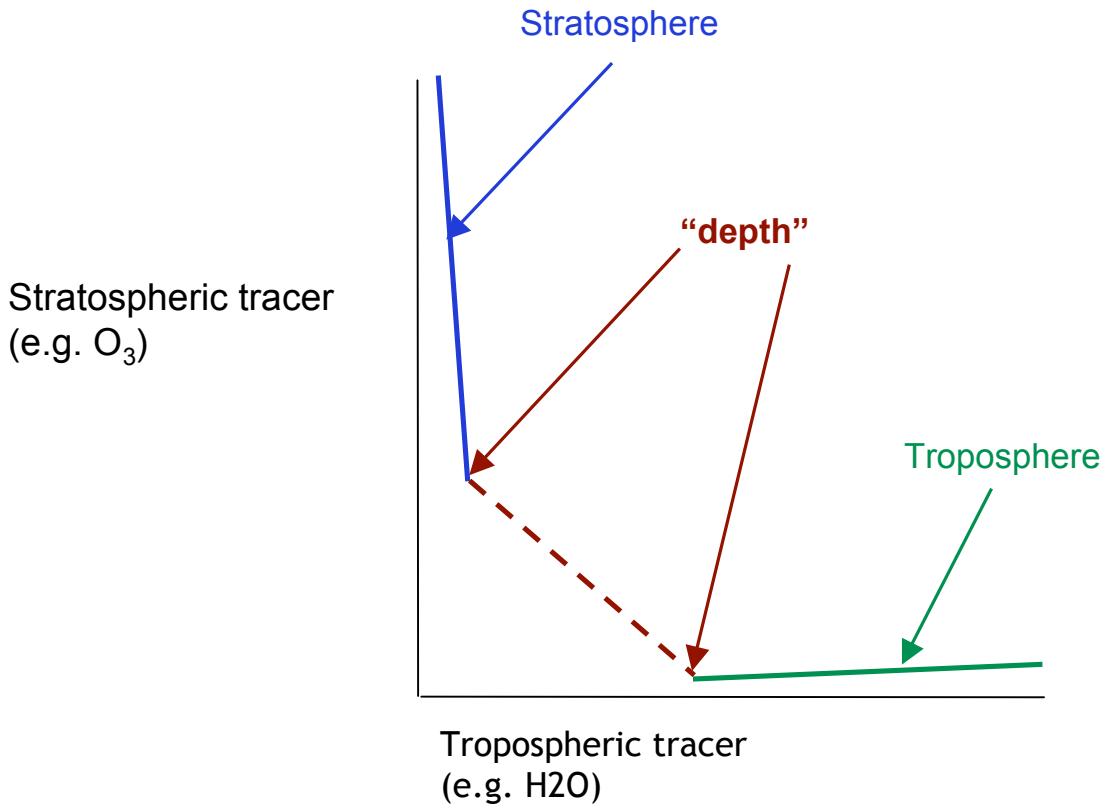
This case demonstrates AIRS CO sensitivity to near the surface under some conditions. DC-8 in situ confirm altitude of Mexico City (600mb) and Monterrey (800 mb) plumes.







Tracer-tracer studies



AIRS O_3–H_2O May 15, 2004, 65N

Laura Pan (NCAR)